

The Feasibility of Common Enterotomy Closure Using Bidirectional Barbed Sutures in Intracorporeal Overlap Anastomosis During Robotic Surgery for Colon Cancer

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Abstract

Background/Aim: Although intracorporeal anastomosis in minimally invasive colectomy has many advantages, it requires a longer operative time than extracorporeal anastomosis. For quick and reliable common enterotomy closure, we proposed a new method using bidirectional barbed sutures. The present study evaluated the safety and feasibility of common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer.

Patients and Methods: A total of 39 patients who underwent common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer were enrolled in this study.

Results: Although minor infectious complications were observed in a few cases, no anastomotic leakage or stricture was observed.

Conclusion: Common enterotomy closure via a new method using bidirectional barbed sutures in intracorporeal overlap anastomosis may be a safe and useful procedure, especially in hospitals newly introducing intracorporeal anastomosis.

Keywords: Intracorporeal anastomosis, common enterotomy closure, colon cancer, bidirectional barbed suture, robotic surgery.

Introduction

Intracorporeal anastomosis in minimally invasive colectomy has many advantages, such as minimal mobilization of the

colon (1-3), prevention of vascular injury due to mesenteric traction when lifting the intestine out of the abdominal cavity (2, 3), avoiding the risk of twisting the mesentery during reconstruction (2, 4), ensuring a sufficient length of



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Received January 16, 2025 | Revised January 29, 2025 | Accepted January 30, 2025



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the distal margin (5, 6), and reducing the incidence of incisional hernia associated with smaller incisions for specimen extraction (7, 8). Therefore, intracorporeal anastomosis in minimally invasive colectomy has gradually become more common in the recent years. In contrast, intracorporeal anastomosis requires a longer operation time than extracorporeal anastomosis (3, 8), and it has been reported that about 20 cases were required to achieve expertise when conducting intracorporeal anastomosis in laparoscopic colectomy (9). In addition, there are concerns about infection and cancer cell dissemination associated with enterotomy in the abdominal cavity (10).

To minimize the time the digestive tract is open and to close a common enterotomy reliably and safely, we previously proposed a procedure involving closure using bidirectional barbed sutures (10). Experiments using a simulator revealed that the duration of common enterotomy closure using one bidirectional barbed suture was significantly shorter than that using two conventional barbed sutures. However, the safety and other clinical outcomes of this procedure have not been evaluated.

The present study evaluated the safety and feasibility of common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer.

Patients and Methods

Patients. The clinical data of patients with colon cancer who underwent robot-assisted colectomy at the Department of Gastroenterological Surgery, Osaka Metropolitan University Hospital between August 2022 and November 2024 were retrospectively collated and analyzed. Eligibility criteria were (i) intracorporeal anastomosis, (ii) overlap anastomosis, and (iii) common enterotomy closure by hand-sewn anastomosis. The exclusion criteria were (i) multiple colorectal cancers and (ii) simultaneous resection of other organs.

The ethics committee of Osaka City University approved this retrospective study (approved number: 4182), which was conducted in accordance with the

Declaration of Helsinki. All patients provided their written informed consent for treatment and data analyses.

Methods. Details regarding the method of common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis have been described in our previous report (10). The procedure is summarized as follows (Figure 1): After evaluating blood perfusion using indocyanine green fluorescence imaging, the oral and anal sides of the intestine were transected using a linear stapler. Small holes were created 6 cm from the anal stump and 2 cm from the oral stump, and overlap anastomosis was performed using a linear stapler. A stay suture, which was used for lifting, was placed at the distal edge of the common enterotomy. A continuous two-layer suture was performed from the proximal edge towards the distal edge using a 3-0 absorbable monofilament bidirectional barbed suture (STRATAFIX® Spiral PDS® Plus Suture, 14+14 cm; ETHICON, Inc., Raritan, NJ, USA). Once the suture reaches the distal edge, it is recommended to go back two stitches toward the proximal edge. The closure of the first layer was a full-thickness suture, and that of the second layer was a seromuscular suture. Regardless of the degree of contamination in the abdominal cavity, it is routinely irrigated with at least 1 l of saline. If the abdominal cavity is severely contaminated, irrigation with ≥ 2 l of saline may be performed.

The surgery was performed by three colorectal surgery experts who were technically qualified surgeons using the endoscopic surgical skill qualification system (11) and had been certified to operate the Da Vinci System as console surgeons. Robotic surgery was performed using the Da Vinci Xi Surgical System (Intuitive Surgical, Sunnyvale, CA, USA).

All patients underwent mechanical and chemical preparations. Polyethylene glycol solution was administered orally as a mechanical bowel preparation, and kanamycin and metronidazole were administered orally as chemical bowel preparations. Although antibiotics are routinely administered only during surgery, if the abdominal cavity is severely contaminated, they may

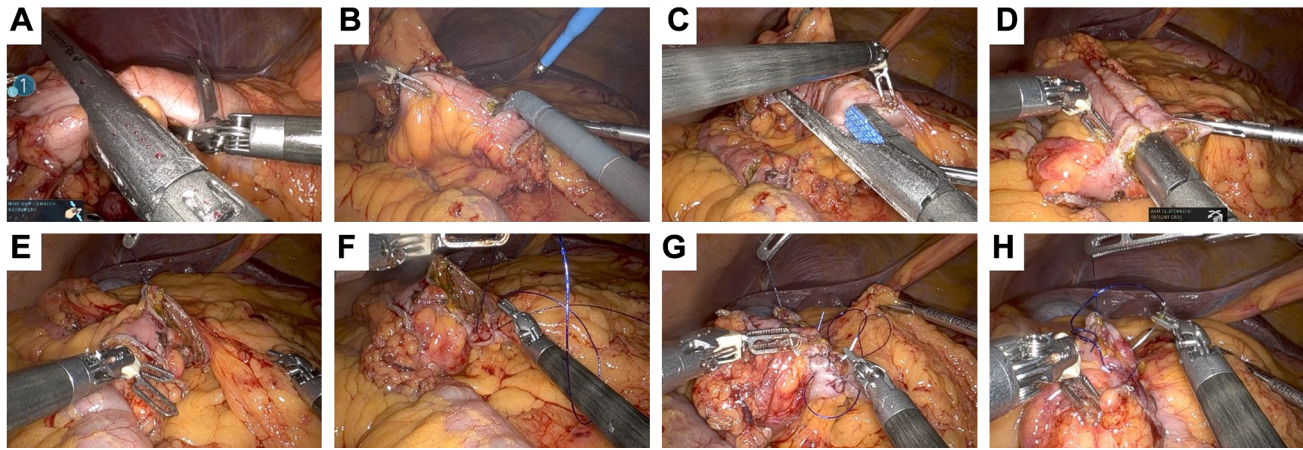


Figure 1. The method of common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis. (A) The intestine was transected using a linear stapler. (B) Small hole was created. (C) The fork of the linear stapler was inserted. (D) Overlap anastomosis was performed. (E) A stay suture for lifting was placed at the distal edge of the common enterotomy. (F) The closure of the first layer was a full-thickness suture. (G)(H) The closure of the second layer was a seromuscular suture.

be administered prophylactically for several days. The type of linear stapler and placement of the drains were decided at the discretion of the surgeon. The primary endpoint of this study was the rate of surgical site infection within 30 days after surgery and anastomotic stricture.

Results

Patient enrollment. A total of 52 patients underwent robot-assisted colectomy for colon cancer. Of these, one patient who underwent simultaneous low anterior resection for rectal cancer and two patients who underwent simultaneous resection of other organs for liver metastasis and renal cell carcinoma were excluded from this study. Furthermore, two patients who underwent extracorporeal anastomosis, six patients who underwent functional end-to-end anastomosis, and two patients who underwent common enterotomy closure with a linear stapler were excluded from this study. After applying the inclusion and exclusion criteria, 39 patients who underwent common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer were finally enrolled in this study (Figure 2).

Table I. Patient characteristics and operative factors.

Sex, n	
Male	18
Female	21
Age (years)	
Median (range)	75 (42-91)
Body Mass Index (kg/m ²)	
Median (range)	22.10 (16.44-26.82)
Tumor location, n	
Cecum	12
Ascending colon	18
Transverse colon	8
Descending colon	1
Operation method, n	
Ileocecal resection	18
Right hemicolectomy	19
Left hemicolectomy	2
Linear stapler, n	
Robotic stapler	20
Laparoscopic stapler	19

Patient characteristics and operative factors. Patient characteristics and operative factors are summarized in Table I. There were 18 men and 21 women, with a median age of 75 years (range=42-91 years). The median body mass index was 22.10 kg/m² (range=16.44-26.82 kg/m²) kg/m². The operation methods were distributed as follows: ileocecal resection, 18; right hemicolectomy, 19;

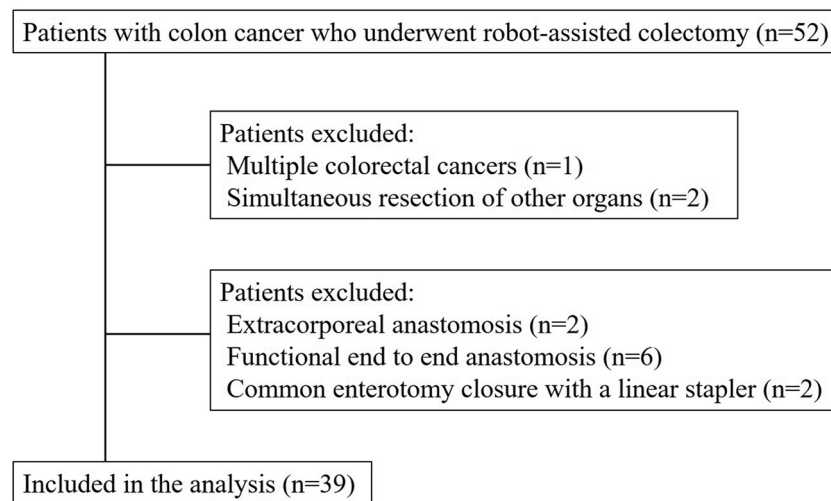


Figure 2. Flow diagram of patient selection in this study.

and left hemicolectomy, 2. The types of linear stapler were distributed as follows: robotic stapler, 20; laparoscopic stapler, 19.

Operative outcomes. The operative outcomes are summarized in Table II. The median operative time was 260 min (range=127-555 min). The median intraoperative blood loss was five ml (range=0-350 ml). No anastomotic leakage or strictures were observed. Persistent intra-abdominal inflammation was observed in two cases (5.1%), wound infection in one case (2.6%), and paralytic ileus in five cases (12.8%). The median postoperative length of hospital stay was nine days (range=6-18 days).

Discussion

In this study, regarding surgical site infection, no anastomotic leakage was observed; only one patient (2.6%) had wound infection and only two patients (5.1%) had persistent intra-abdominal inflammation. In two cases of persistent intra-abdominal inflammation, none developed an intra-abdominal abscess, and both improved with the administration of antibiotics for several days. However, paralytic ileus was observed in five cases (12.8%). Some cases of paralytic ileus may have been

Table II. Operative outcomes.

Operation time (min)	
Median (range)	260 (127-555)
Console time (min)	
Median (range)	199 (85-481)
Amount of intraoperative blood loss (ml)	
Median (range)	5 (0-350)
Postoperative infectious complications, n (%)	
Anastomotic leakage	0 (0%)
Persistent intraabdominal inflammation	2 (5.1%)
Wound infection	1 (2.6%)
Paralytic ileus	5 (12.8%)
Anastomotic stricture, n (%)	0 (0%)
The length of hospital stays (days)	
Median (range)	9 (6-18)

caused by persistent intra-abdominal inflammation. Nevertheless, the median postoperative length of hospital stay for patients who developed paralytic ileus was 15 days, and all patients were discharged within 18 days after the operation. Furthermore, there were no cases of anastomotic strictures. These results suggest that common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer may be safe and useful.

Although common enterotomy closure with a linear stapler is useful (12), hand-sewn closure of the common

enterotomy is recommended in the early stages of intracorporeal anastomosis introduction. If the hole for inserting the fork of the linear stapler is too small, it will be difficult to insert the fork of the linear stapler, and forcibly inserting the fork of linear stapler may damage the intestinal tract. Therefore, the hole for inserting the fork of the linear stapler is often made slightly larger than strictly necessary. However, if the hole for inserting the fork of the linear stapler is too large, closure of the common enterotomy with the linear stapler will be difficult. Forcibly closing a large common enterotomy with a single staple may result in anastomotic stricture. In addition, if the center of the common enterotomy is hollow, full-thickness stapling may not be possible, resulting in an increased risk of anastomotic leakage. Although there is an option to lift the center of the common enterotomy with stay sutures to prevent the center of the common enterotomy from being hollow, this does not make much difference in the effort required for hand-sewn closure.

In intracorporeal anastomosis, the risk of postoperative intra-abdominal infection increases if the abdominal cavity is contaminated with feces during surgery, although this is not limited to the procedure of common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis. In the present study, there were several cases of high serum C-reactive protein levels after surgery as well as paralytic ileus. Previous studies have demonstrated that intracorporeal anastomosis contributes to earlier restoration of the bowel function (3, 13). However, persistent intra-abdominal inflammation associated with fecal contamination during gastrointestinal reconstruction may lead to the development of paralytic ileus. To prevent persistent postoperative inflammation in the abdominal cavity, the following measures are necessary: (i) sufficient mechanical and chemical preparation, (ii) rapid suction of stool to prevent it from spilling into the abdominal cavity when opening the digestive tract, (iii) sufficient intraperitoneal lavage in case of contamination, and (iv) placement of a drain as needed. In addition, intracorporeal anastomosis should not be selected in cases where the tumor is large and appropriate preparation cannot be

performed. When a small hole is made in the intestine to insert the fork of the linear stapler, there is a risk of fecal contamination in the abdominal cavity. When opening the digestive tract, an assistant must be ready to suction the contents of the digestive tract quickly. In addition, the risk of abdominal contamination can be reduced by lifting the distal edge of the common enterotomy with stay sutures.

Study limitations. First, this was a retrospective study with a small number of cases from a single center. Second, this study only examined the safety of common enterotomy closure by using bidirectional barbed sutures and did not compare its usefulness and safety with the procedure of common enterotomy closure with a linear stapler. After the procedure has stabilized, common enterotomy closure with a linear stapler may be faster; however, in the early stages of the introduction of intracorporeal anastomosis, common enterotomy closure using bidirectional barbed sutures is recommended for reliability and safety. Third, intraoperative and postoperative management following intracorporeal anastomosis has not yet been established. Antibiotics were routinely administered only during surgery; however, in cases of severe contamination or high inflammatory responses on the first postoperative day, antibiotics were sometimes administered for several days after surgery. In addition, the drain placement was performed at the surgeon's discretion. As is common to all intracorporeal anastomoses, indicators for assessing the degree of intra-abdominal contamination, optimal amount of irrigation, antibiotic administration, and drain placement should be discussed in future studies. In addition, this study only evaluated short-term outcomes and did not evaluate oncological outcomes, such as recurrence of peritoneal dissemination. Further research is required to clarify this issue.

Conclusion

Common enterotomy closure using bidirectional barbed sutures in intracorporeal overlap anastomosis during robotic surgery for colon cancer may be a safe and useful

procedure, especially in hospitals that have newly introduced intracorporeal overlap anastomosis after colectomy.

Conflicts of Interest

The Authors declare no conflicts of interest in association with the present study.

Authors' Contributions

MS designed the study, performed the statistical analysis, and drafted the manuscript. TF, HK, SO, HT, KY, YS, and KM collected clinical data and critically reviewed the manuscript.

Acknowledgements

The Authors thank Brian Quinn, who provided medical writing services on behalf of JMC Ltd.

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